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IECEE
OPERATIONAL DOCUMENT

IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components (IECEE System)

Committee of Testing Laboratories (CTL)

Procedure for measuring Laboratory Power Source characteristics

IECEE OD-5010:2015(EN)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE ZZ

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Background

The CTL decided in 2014 to convert the CTL Operational Procedure (OP) into the IECEE Operational Document (OD) structure. The content of the former OP's has not been changed. Editorial adjustments have been made where necessary. The forms have been separated into independent documents for better handling.

A transfer table which CTL/OP has been transferred into which OD is given in OD 5000.

1 Purpose

1.1 The purpose of this document is to establish a procedure for measuring laboratory power source characteristics at test connection locations. Conformance with the default characteristic requirements for laboratory power sources established by the IECEE CB Scheme is determined with reference to the requirements in IEC/ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories", clauses 5.3.1 and 5.3.2.

1.2 The results of many tests on electrical products tested in accordance with product safety testing standards depends of the characteristics of electrical power source used to power the product under test. Some examples of how power source characteristics can affect test results are:

a) Temperatures on electrical heat generating parts are affected by the voltage applied. In most cases an increase in voltage causes an increase in temperature. While, for some products, a decrease in voltage also results in an increase in temperature.

b) The frequency of the power source can also affect temperatures on electrical heat generating parts such as motors, transformers and solenoids.

c) The harmonic distortion of a power source not only affects temperature of electrical heat generating parts such as motors, transformers and solenoids, but may also affect leakage currents for the product.

Accordingly, testing standards specify the voltage, frequency and wave shape of the power source to be used - for example 230 V, 50 Hz, sinusoidal power source. These specifications in the standard are made with the understanding that the specified characteristics are maintained as stated throughout the testing. In the real world, however, a power source that meets these ideal specifications is not possible. Some standards recognize this and include tolerances for the power source specifications, while other standards do not. The CTL has proposed default power source stability requirements to be followed when the test standard does not contain tolerances/requirements for the power source to be used. These power source stability requirements define the characteristics of real world power sources that can be used in the testing laboratory, so that laboratories can obtain consistent, uniform and repeatable results and, thus, further the exchange of testing data among members of the CB Scheme.

2 Scope

2.1 The procedure described in this document applies to measurement of laboratory power source voltage and frequency stability, and total harmonic distortion (THD) to determine conformance with the default characteristic requirements for laboratory power sources established by the IECEE CB Scheme.

2.2 This guide applies to the following situations:

Testing is performed within the maximum rated current of the test connection location.

Normal operating conditions of the tested product.

2.3 The test circuit stability requirements in this operating procedure apply to testing of products that are connected to ordinary branch circuits found in residences and businesses - for example 120 V, 15 and 20 A; 240 V, 15 A circuits in North America and 230 V, 10 and 16 A branch circuits in Europe.

2.4 When a test circuit is evaluated according to this operating procedure and determined to be compliant, it is permissible to record the initial test condition only without further monitoring of the power source;

When test circuit is used to perform tests beyond the evaluated scope of the circuit, then the circuit shall be monitored for stability throughout the performance of testing.

2.5 Requirements for laboratory power sources used to test products on other types of power sources than mentioned in clause 2.4 are not specifically given in this operating procedure. Nevertheless those laboratory power sources still need to comply with the requirements in IEC/ISO 17025, clauses 5.3.1 and 5.3.2.

2.6 Exclusions

2.6.1 This operating procedure applies only to laboratory power sources supplying power to equipment under test. It does not apply to laboratory "house power", which is power that is supplied for instruments, ambient chambers, lights and the like.

2.6.2 This operating procedure does not apply to DC power sources used to supply power to DC rated electrical equipment under test.

2.6.3 This operating procedure does not apply to testing of photovoltaic arrays. Photovoltaic arrays generate their own power. The requirements do apply to testing of auxiliary equipment used with photovoltaic arrays if the auxiliary equipment in used is connected to the branch circuits cited.

2.6.4 The requirements apply to stability of laboratory power sources only. The requirements do not address short circuit current testing, abnormal testing, switching testing, and the like, that relate to source capacity.

2.6.5 These requirements do not apply to EMC testing.

3 Normative References

The following publication contain provisions which, through reference in this text, constitute modification or additions of this Operational Document.

ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories
IEC 60038	IEC Standard Voltages

4 Definitions

4.1 Definitions unique to this document

4.1.1 Automatic adjustment (power source)

Regulation of power source by electronic, electrical or mechanical means that automatically maintains the voltage and/or frequency at a prescribed value.

4.1.2 Manual adjustment (power source)

Regulation of power source by manual adjustment of an autotransformer, tapped transformer with selector switch or similar means to maintain the voltage and/or frequency at a prescribed value.

4.1.3 Nominal voltage

The circuit voltage provided at the test connection location (refer to 9.1.5).

4.1.4 Robust power source

Power source of sufficient capacity to meet the power source stability requirements without the need for further regulation or adjustment.

4.2 Acronyms unique to this document

4.2.1 Maximum open circuit voltage, $V_{oc,max}$

4.2.2 Minimum open circuit voltage, $V_{oc,min}$

4.2.3 Maximum voltage loaded, $V_{ld,max}$

4.2.4 Minimum voltage loaded, $V_{ld,\ min}$

4.2.5 Current loaded, I_{ld}

4.2.6 Voltage nominal, V_{nom}

4.2.7 Maximum frequency open circuit, $F_{oc,max}$

4.2.8 Minimum frequency open circuit, $F_{oc,min}$

4.2.9 Maximum frequency loaded, $F_{ld,max}$

4.2.10 Minimum frequency loaded, $F_{ld,\ min}$

4.2.11 Maximum harmonic distortion open circuit, THD_{oc}

4.2.12 Maximum harmonic distortion loaded, THD_{ld}

4.3 Equations unique to this document

4.3.1 Voltage regulation open circuit

$$\text{Reg } V_{oc} = [MAX(V_{oc,max} - V_{nom};\ V_{nom} - V_{oc,\ min})/V_{nom}] \times 100\%$$

4.3.2 Voltage regulation loaded

$$\text{Reg } V_{ld} = [MAX(V_{ld,max} - V_{nom};\ V_{nom} - V_{ld,\ min})/V_{nom}\ ] \times 100\%$$

4.3.3 Frequency regulation open circuit

$$\text{Reg } F_{oc} = [MAX(F_{oc,max} - F_{nom};\ F_{nom} - F_{oc,\ min})/F_{nom}\ ] \times 100\%$$

4.3.4 Frequency regulation loaded

$$\text{Reg } F_{ld} = [MAX(F_{ld,max} - F_{nom};\ F_{nom} - F_{ld},\ min)/F_{nom}] \times 100\%$$

Note: Function **MAX(value 1; value 2)** returns the maximum of **value 1** and **value 2**.

Example: In the calculation $MAX(V_{oc\ max} - V_{nom};\ V_{nom} - V_{oc\ min})$ use the maximum value of either upper $(V_{oc\ max} - V_{nom})$ or the lower $(V_{nom} - V_{oc\ min})$."

4.3.5 Total Harmonic Distortion

THD = SQRT(sum of all squares of amplitude of all harmonic voltages/square of the amplitude of the fundamental voltage) x 100%

5 Responsibility of the laboratory

5.1 Laboratory power source measurements shall be performed upon initial installation, modification and repair of the laboratory power source(s) to confirm that appropriate power quality exists at the test connection locations.

5.2 In accordance with ISO/IEC 17025:2005, clause 5.3.2, it is the responsibility of the laboratory to monitor, control and record characteristics of the laboratory power source to ensure continued conformance with the requirements. Considerations to be taken into account include changes in characteristics of the power as supplied by the electric utility (or other source), changes in load conditions on the power source substation due to power consumption of neighboring businesses and effects of other testing being conducted in the laboratory.

6 General

Instructions given in this document are to be followed to assure test consistency and repeatability.

7 Equipment

7.1 Instruments:

7.1.1 Voltmeter

7.1.2 Ammeter

7.1.3 Frequency meter

7.1.4 Total harmonic distortion analyzer

7.1.5 Resistive loads

7.1.6 Accuracy of meters shall conform to the most recent version of CTL DSH-251.

7.1.7 Meter calibrations are to be traceable to SI units.

Note 1: Other types of equipment providing equivalent functionality may be used.

8 Requirements

8.1 When not otherwise specified in the testing standard, the test connection location shall meet the following requirements:

8.1.1 Voltage stability: +/- 3 percent maximum

8.1.2 Frequency stability: +/- 2 percent maximum

8.1.3 Total harmonic distortion (THD): maximum 5 percent

8.2 Conditions are to be maintained at the point of testing.

8.3 Voltage regulation may be achieved by:

8.3.1 Robust source

Acceptable for all situations.

8.3.2 Automatic Adjustment

Acceptable for all normal operating conditions. May be used for varying load conditions if regulator is sufficiently robust and fast acting to handle the load change.

8.3.3 Manual adjustment

Such as auto-transformer in conjunction with periodic voltage monitoring and adjustment (for example every 15 minutes minimum) to ensure voltage is constant.

9 Procedures

9.1 Method

9.1.1 Characteristics of electrical power sources representing electrical mains connections used in the testing laboratory shall be measured at the point where tests are performed. Typically, this point is considered to be a test station receptacle or wiring terminals, a test connection location, where the test setup is connected.

a) For voltage stability, the connection location with the longest wiring distance from the main source can be considered as the ‘worst case’ condition and may represent other

connections on the same circuit. This location may be determined by the power system wiring diagram;

b) For frequency stability, any test location may represent entire network;

c) For total harmonic distortion (THD), Confirmation shall be made that the selected location(s) properly represents the other connection points on the circuit.

9.1.2 There are generally three types of arrangements for AC power regulators used for laboratory test power locations:

a) Central regulator with power distributed to test stations by branch circuit wiring.

b) Regulator located at test station with product under test either connected directly to the regulator output or connected to the regulator through a receptacle or terminals on the test station in turn connected to the regulator through a short distance of adequately sized wiring.

c) Mobile regulators moved to test locations in the laboratory where needed with product under test, either connected directly to the regulator output or connected to the regulator, through a receptacle or terminals connected to the regulator through short distance of adequately sized wiring.

9.1.3 Test location connection voltage stability, frequency and total harmonic distortion shall be measured.

9.1.4 While it is expected that the test location power meet the required specifications throughout the duration of any testing performed, measurement of test location power characteristics are normally made over a one hour period in open circuit and loaded conditions, unless there is reason to believe that measurements made over a longer period is necessary to establish conformance with the intent of the requirements. Alternately, the test connection location power characteristics may be measured during the test.

9.1.5 Initially, the nominal voltage, frequency and total harmonic distortion of the test location

connection shall be measured open circuit over a period of one hour. Nominal voltage values for circuits may be found in Table 1 of IEC 60038 “IEC Standard Voltages”. The permissible tolerances for nominal voltage values are obtained from Table A1 of IEC 60038. The nominal voltage at the beginning of the measurement shall be within the “Highest supply or utilization voltage” and “Lowest supply voltage” ranges as given in Table A.1 of IEC 60038. The test location voltage shall not exceed these values.

9.1.6 Afterwards, the test connection location shall be loaded to rated maximum normal resistive load (continuous duty). The voltage, frequency and harmonic distortion shall be measured again over a period of one hour. The test location power shall comply with the requirements in this document throughout this one hour period. If a voltage change occurs and the circuit includes a manual adjustment means (e.g. variable transformer), re-adjustment is permitted to compensate for the loaded circuit voltage change under the following conditions:

1) The voltage re-adjustment necessary to return voltage back to the measured open circuit nominal voltage shall be recorded;

2) The voltage re-adjustment value must be within the limit given in 8.1.1 and the test connection location *voltage stability* must remain within the limit given in 8.1.1 during the 1 hour continuous duty loading.

3) If the voltage re-adjustment value exceeds the limit of 8.1.1, the test connection location *voltage stability* must remain within the limits given in 8.1.1 during the 1 hour continuous loading. If the voltage stability meets the requirement of 8.1.1, the test location is to be identified such that the users are aware that the test connection location is limited for use with continuous loads only.

9.1.7 Where the voltage stability of the test connection location does not meet the requirement of 8.1.1 at the rated load of the circuit, a reduced load value may be applied to

provide compliance to the voltage stability requirement in 8.1.1. The reduced load rating of the test circuit location shall be identified such that users are aware of the load limitations.

9.1.8 Sequence 9.1.5 and 9.1.6 shall be performed for all combinations of voltage/frequency used for testing at the test connection location.

10 Values to be recorded/calculated

10.1.1 Maximum open circuit voltage, Voc,max

10.1.2 Minimum open circuit voltage, Voc,min

10.1.3 Maximum voltage loaded, Vld,max

10.1.4 Minimum voltage, Vld, min

10.1.5 Current loaded, Ild, max

10.1.6 Voltage nominal, V nom = specified test voltage (e.g. 120 V, 230 V, 240 V)

10.1.7 Maximum frequency open circuit, Foc,max

10.1.8 Minimum frequency open circuit, Foc,min

10.1.9 Maximum frequency loaded, Fld,max

10.1.10 Minimum frequency loaded, Fld, min

10.1.11 Maximum harmonic distortion open circuit, THDoc

10.1.12 Maximum harmonic distortion loaded, THDld

11 Records

11.1 Records shall be made and retained of measurements made, calculated values, location of measurements and conditions of measurements in accordance with the responsibility noted in clause 4 and required laboratory practice under ISO/IEC 17025. Annex A (informative) contains a suggested format for recording the data.

11.2 Records of the power distribution system shall include wiring diagrams, identification of voltages, frequencies, number of phases, capacities, fuse/circuit breaker ratings and regulation equipment.

Annex A Format for recording data (Informative)

Date: Tested by (name/signature):

Power Source Stability Test:

Method

Power source stability characteristics were measured in accordance with OD-5010.

Results

Location and characteristics: _____

• **Measured Quantity**	• **Value**
• Voltage nominal, V nom =	•
• Maximum open circuit voltage, $V_{oc,max}$ =	•
• Minimum open circuit voltage, $V_{oc,min}$ =	•
• Current loaded, $I_{ld,\ max}$ =	•
• Maximum voltage loaded, $V_{ld,max}$ =	•
• Minimum voltage, $V_{ld,\ min}$ =	•
• Maximum frequency open circuit, $F_{oc,max}$ =	•
• Minimum frequency open circuit, $F_{oc,min}$ =	•
• Maximum frequency loaded, $F_{ld,max}$ =	•
• Minimum frequency loaded, $F_{ld,\ min}$ =	•
• Maximum harmonic distortion open circuit, THD_{oc} =	•
• Maximum harmonic distortion loaded, THD_{ld} =	•
• Reg V_{oc} = [MAX($V_{oc,max}$ - V_{nom}; V_{nom} - $V_{oc,\ min}$)/V_{nom}] x 100% =	•
• Reg V_{ld} = [MAX($V_{ld,max}$ - V_{nom}; V_{nom} - $V_{ld,\ min}$)/V_{nom}] x 100% =	•
• Reg F_{oc} = [MAX($F_{oc,max}$ - F_{nom}; F_{nom} - $F_{oc,\ min}$)/F_{nom}] x 100% =	•
• Reg F_{ld} = [MAX($F_{ld,max}$ - F_{nom}; F_{nom} - F_{ld}, min)/F_{nom}] x 100% =	•

Test Equipment Used

Name	Manufacturer	Model	Range	Last Calibration	Next Calibration
Voltmeter					
Ammeter					
Frequency meter					
THD Analyzer					
Load				N/A	N/A

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